Mars Reconnaissance Orbiter (MRO): Extended Dual-Purpose Mission

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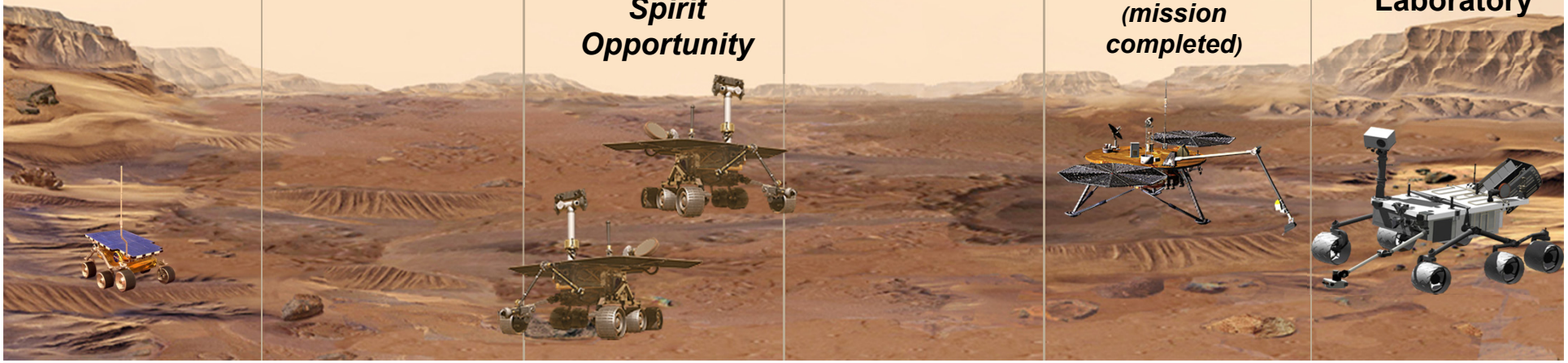
Presentation Outline

- Mars Exploration – Current Decade
- MRO Spacecraft Roles and Mission Status
  - *High Resolution Science Platform*
  - *Communications Relay for Landed Missions*
  - *Landing Site Scout*
  - *Summary (at the end of the Prime Mission)*
- Extended Mission Objectives and Plans

This Decade Mars Exploration

Launch Year

1996	2001	2003	2005	2007	2011
Mars Global Surveyor (*mission completed*)	Mars Odyssey	Mars Express Collaboration	Mars Reconnaissance Orbiter	Phoenix (*mission completed*)	Mars Science Laboratory
Mars Pathfinder (*mission completed*)		MEP Rovers *Spirit* *Opportunity*			



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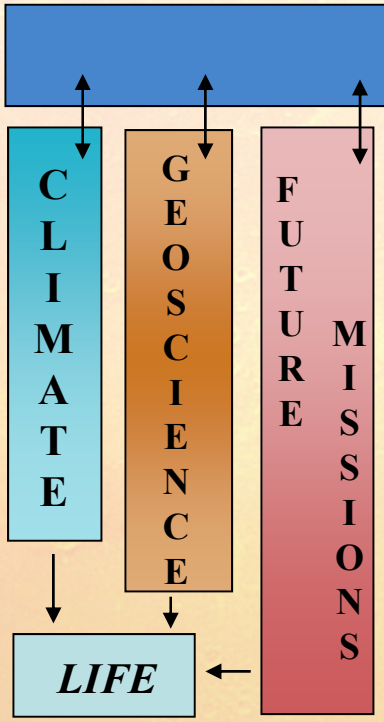
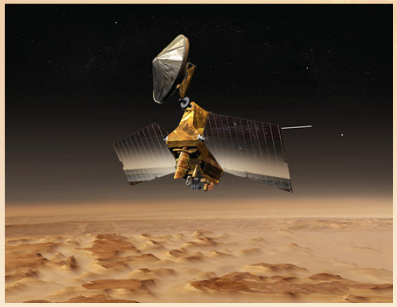
MRO Has Many Roles





- ***Weather and Climate Satellite***
  - *Monitor the present climate, seasonally and year-to-year*
  - *Alerts Mars Exploration Rovers to evolving dust storm events*
  - *Monitored atmosphere for Phoenix as it approached Mars entry*
- ***Geological Explorer***
  - *Identified water-related landforms and aqueous surface deposits*
  - *Probed the subsurface looking for layering and water (ice)*
- ***Site Finder***
  - *Observed hundreds of sites at very high-resolution to find the best places for future landed exploration*
  - *MRO data led Phoenix to a new site, also characterized & certified by MRO*
- ***Communications Satellite***
  - *Provided relay for Phoenix (2008) augmenting relay by Mars Odyssey*
  - *Will provide critical event coverage (entry, descent and landing) and relay for Mars Science Laboratory (2012-2013)*
- ***Technology Pathfinder***
  - *Demonstrated optical navigation and use of new telecom frequencies (Ka-band) for future missions*


NASA
JPL
MRO Spacecraft
Mars
Reconnaissance
Orbiter
SHARAD
HiRISE
UHF
CTX
MARCI
MCS
CRISM
THE UNIVERSITY OF ARIZONA.
Malin Space Science Systems
THE JOHNS HOPKINS UNIVERSITY
agenzia spaziale italiana
CALIFORNIA INSTITUTE OF TECHNOLOGY
GWU
MIT
LOCKHEED MARTIN

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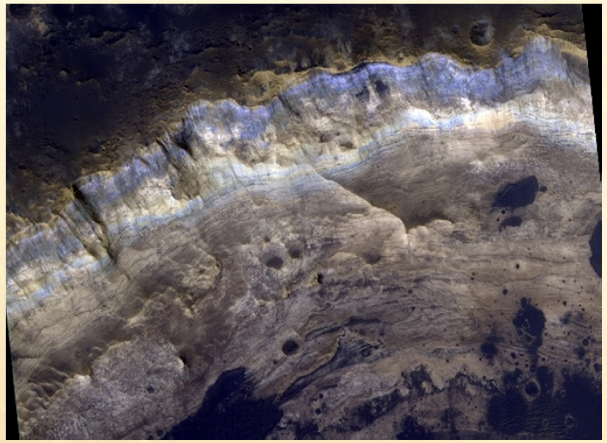
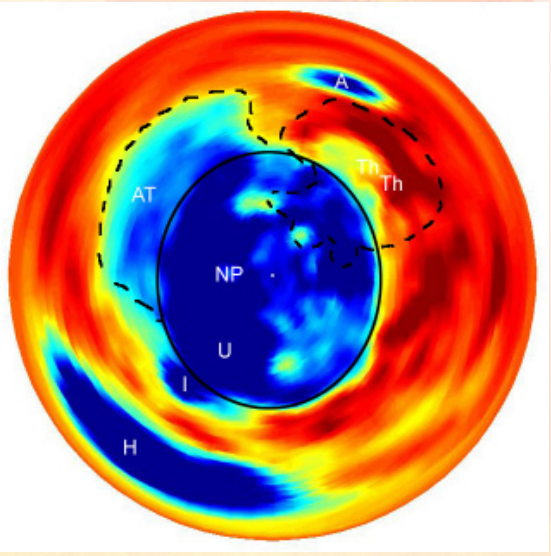
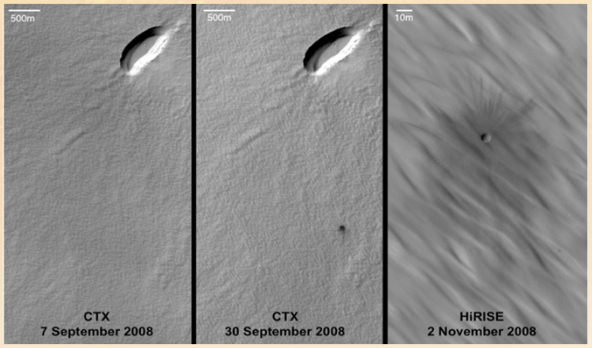
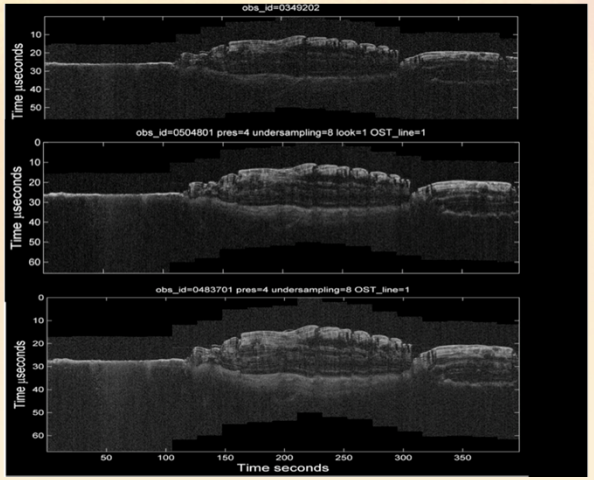
Science Status

- HiRISE
- CRISM
- CTX
- MARCI
- MCS
- SHARAD
- Gravity
- Upper Atmospheric Structure









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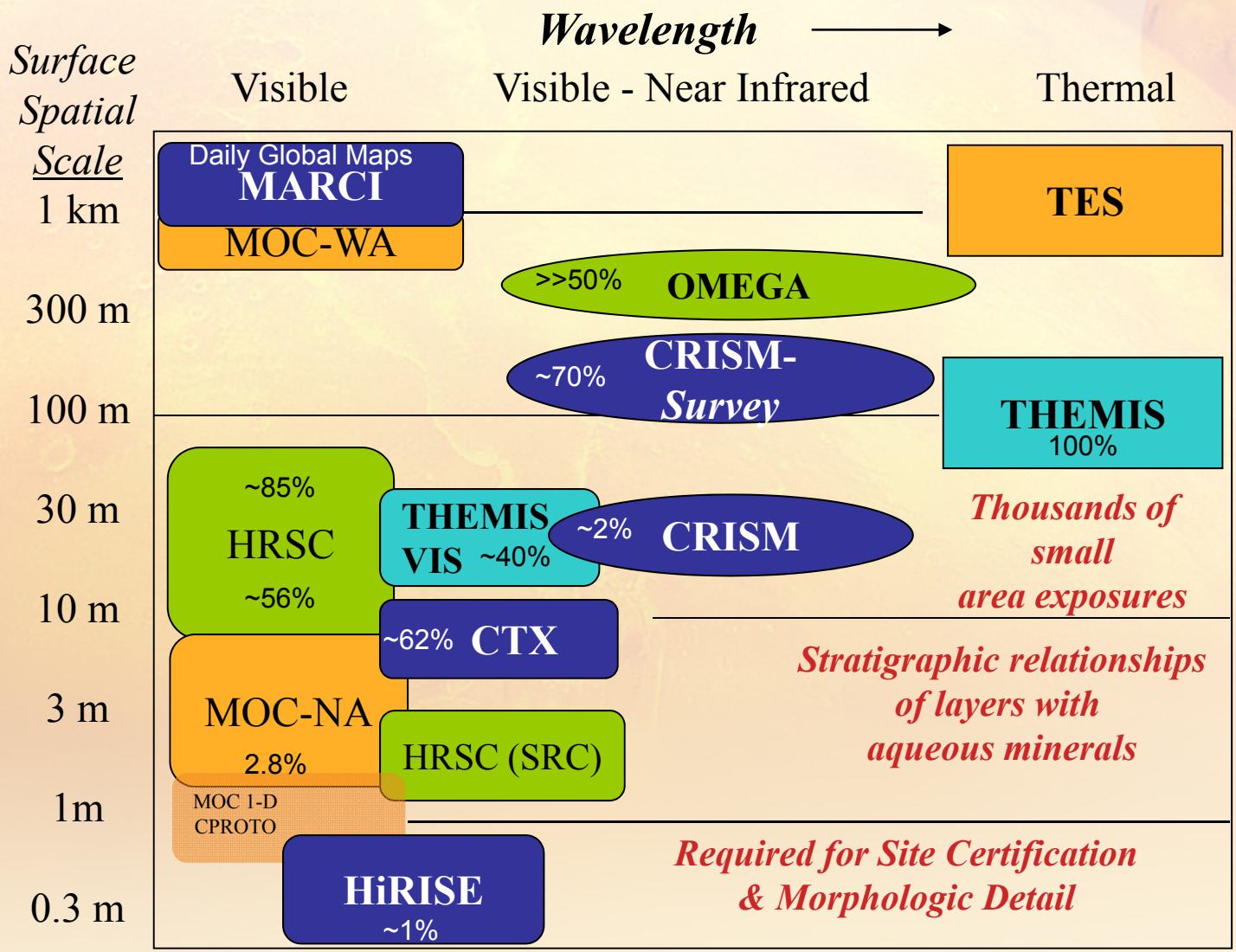
Gains in Resolution



MGS
ODY
MEX
MRO

Phenomena

Sea beds?
Channels

Polar Layering
Paleolakes?
Salt Flats?

Layering
Vents/Springs?
Mineral Deposits

Gullies
Debris Fans
Fine Layering

Patterned Ground
Fractures

Rocks

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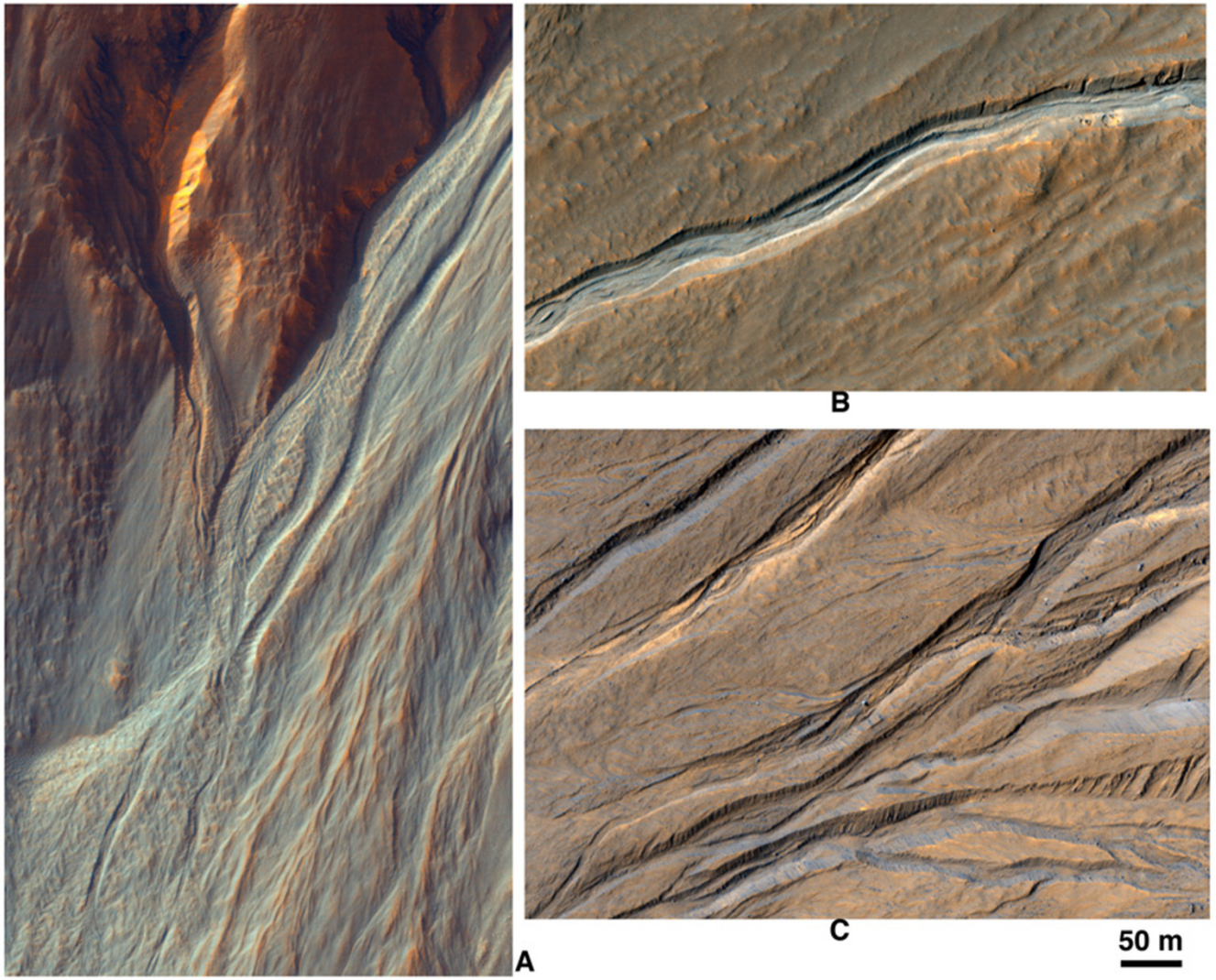
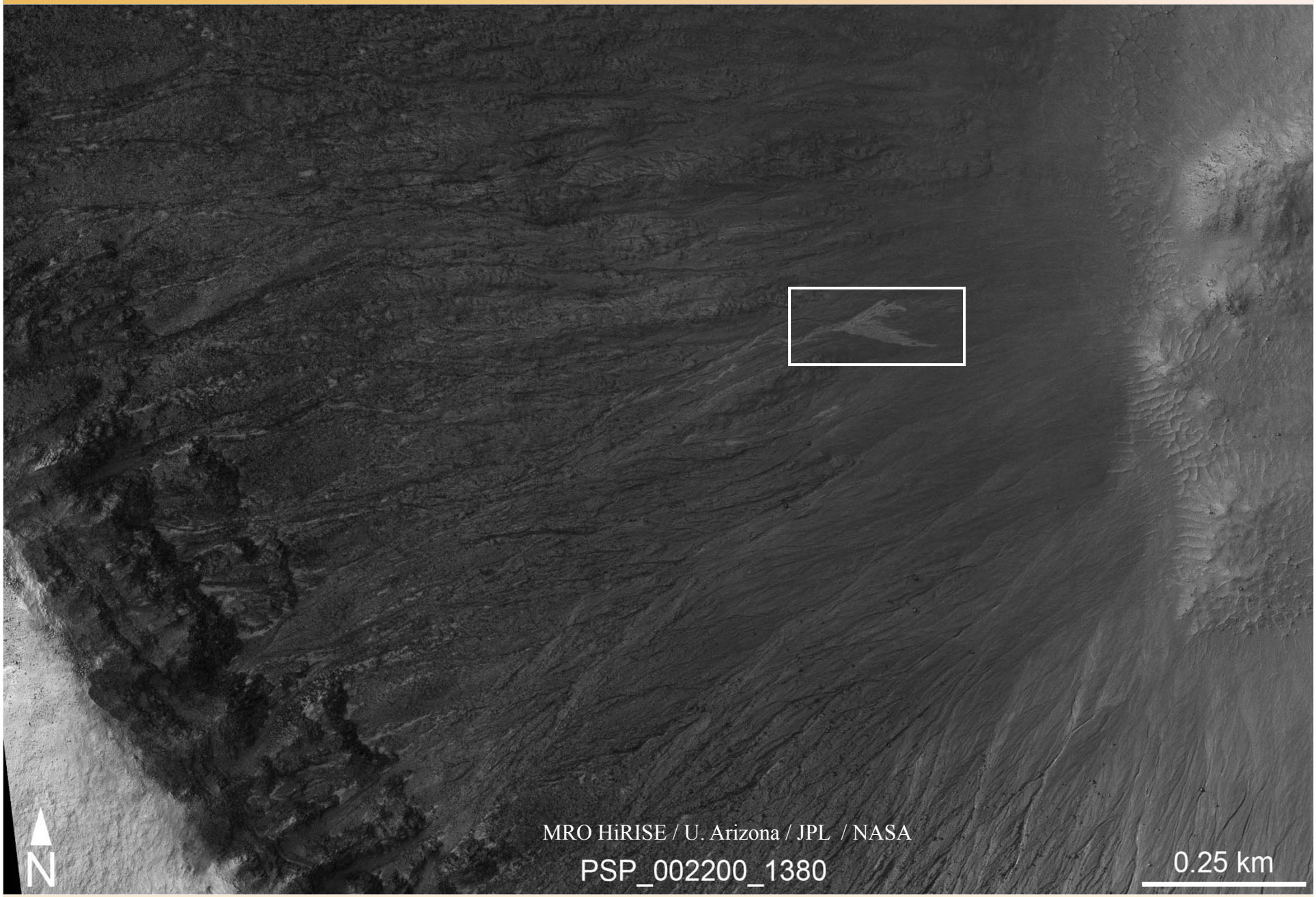
Gully Channels: Geologically Recent Flows



MRO HiRISE / U. Arizona / JPL / NASA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MRO HiRISE / U. Arizona / JPL / NASA
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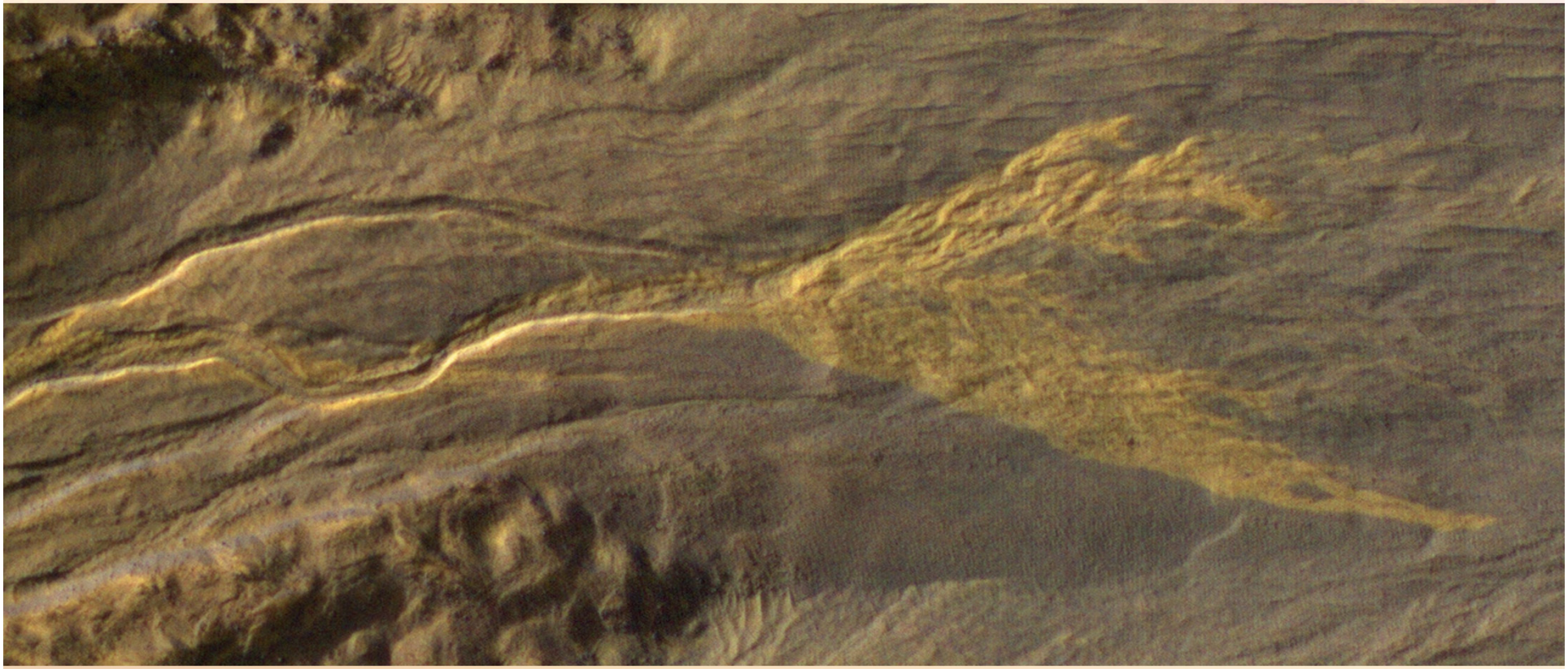
0.25 km



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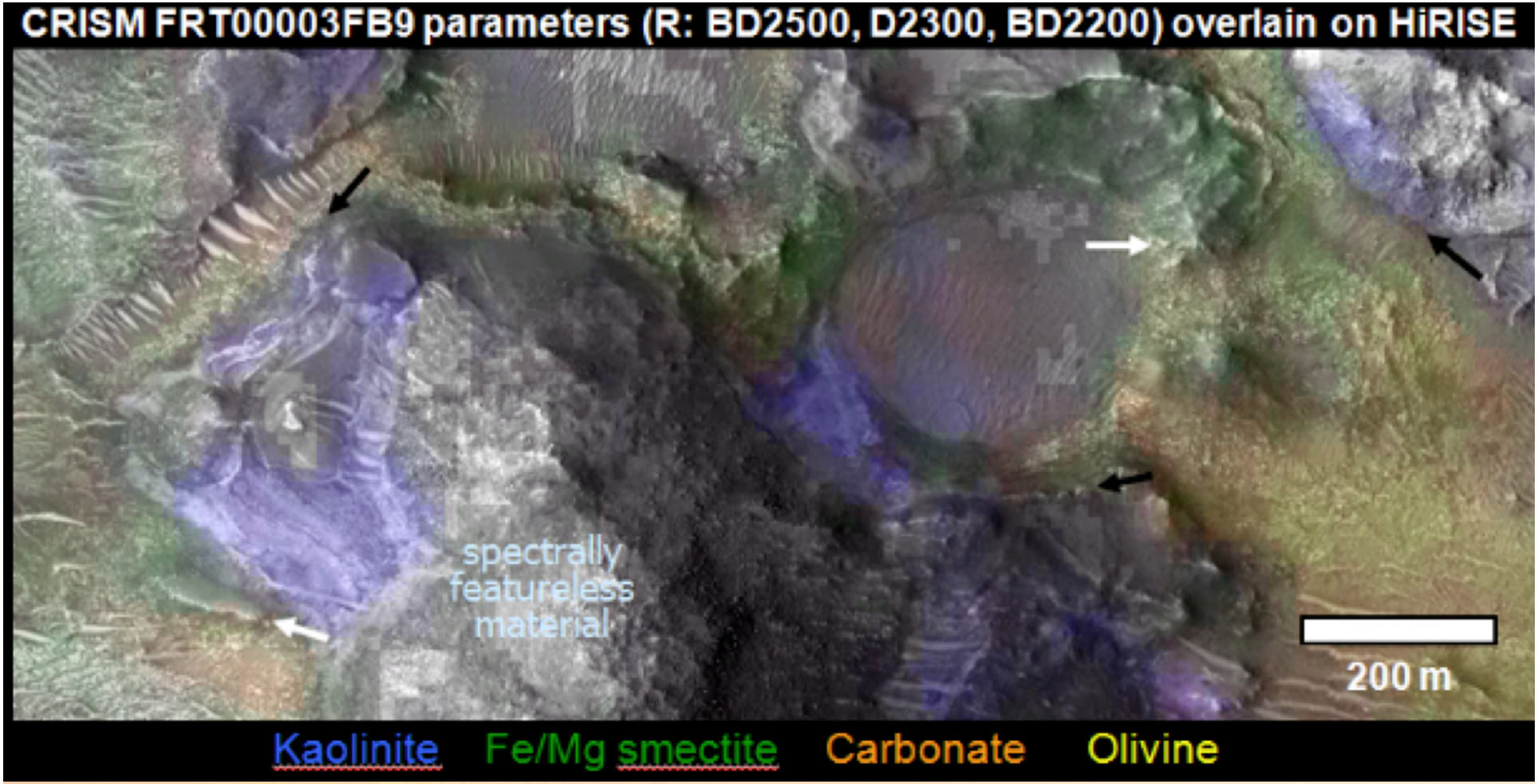

Diverse Mineralogy of Mars

Largest exposure of carbonate-bearing rock observed so far on Mars is found in the Nili Fossae region in the northeastern sector of the prominent dark area known as Syrtis Major. This scene illustrates the complex geologic history of Mars in that different aqueous minerals and unaltered materials are located in close proximity. This diversity of environments increases the probability that life originated on Mars and, if so, will have left some evidence preserved on its surface.

Credits: MRO CRISM / JHUAPL / JPL / NASA MRO HiRISE / U. Arizona / JPL / NASA

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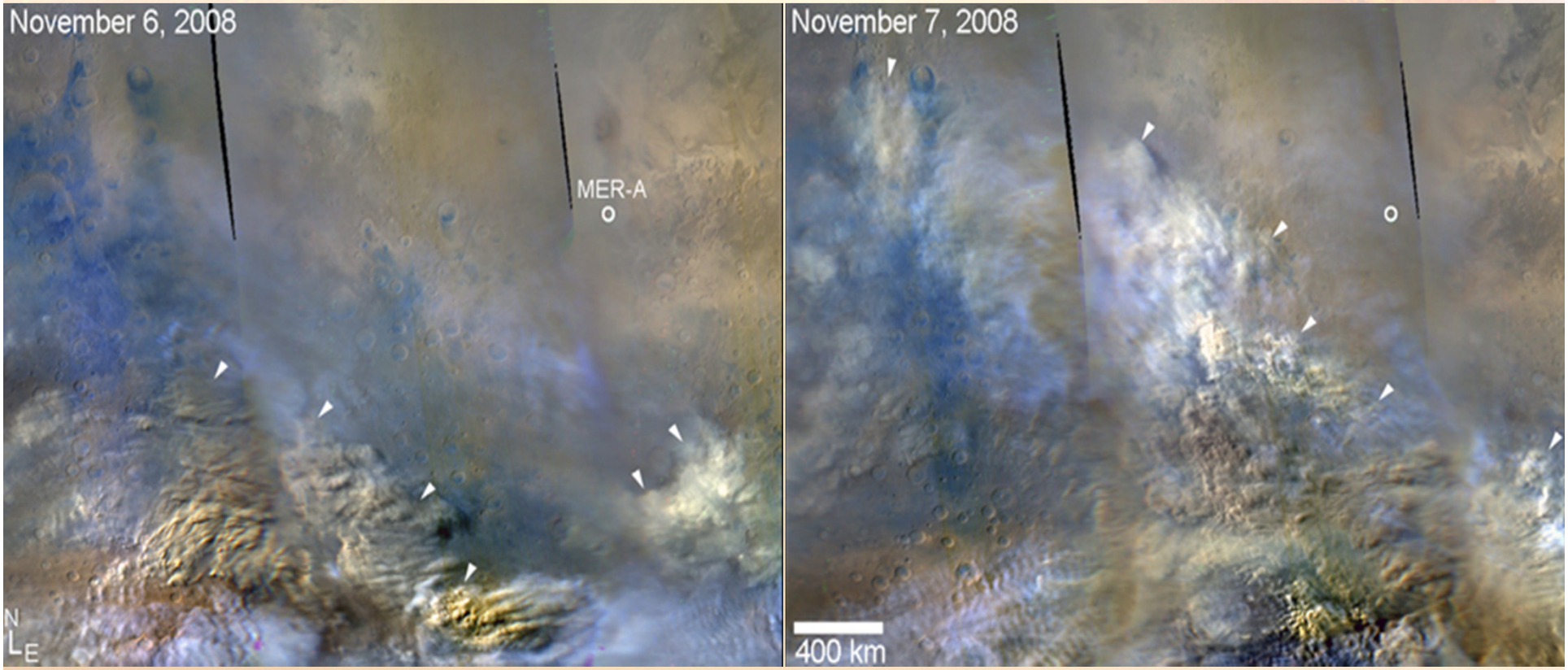
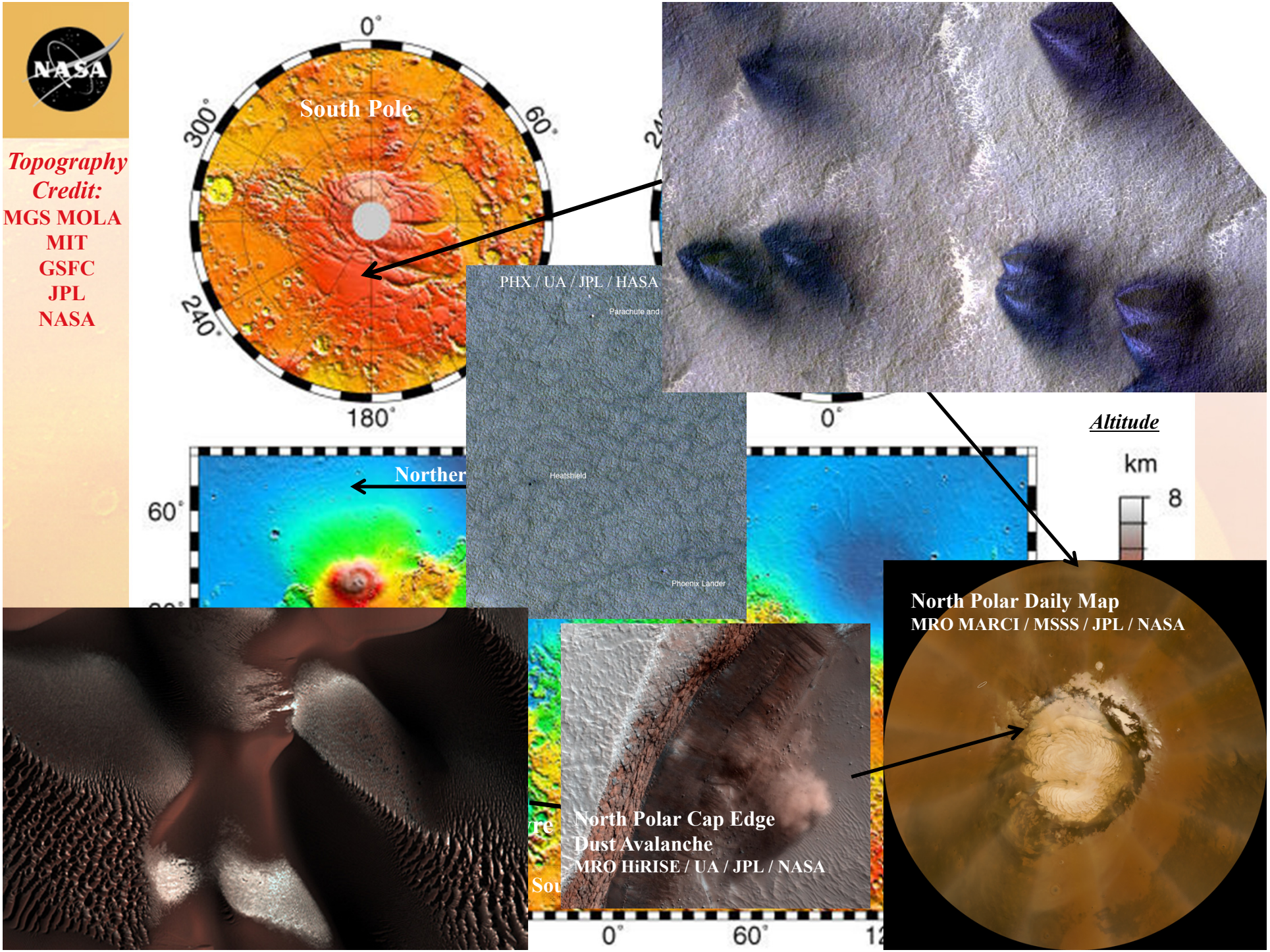
Mars Weather Watch



From MRO MARCI Daily Global Map

MRO MARCI / MSSS / JPL / NASA


Topography Credit:
MGS MOLA
MIT
GSFC
JPL
NASA
South Pole
0°
60°
180°
240°
300°
PHX / UA / JPL / HASA
Parachute and
Heatshield
Phoenix Lander
Altitude
km
8
North Polar Daily Map
MRO MARCI / MSSS / JPL / NASA
North Polar Cap Edge
Dust Avalanche
MRO HiRISE / UA / JPL / NASA

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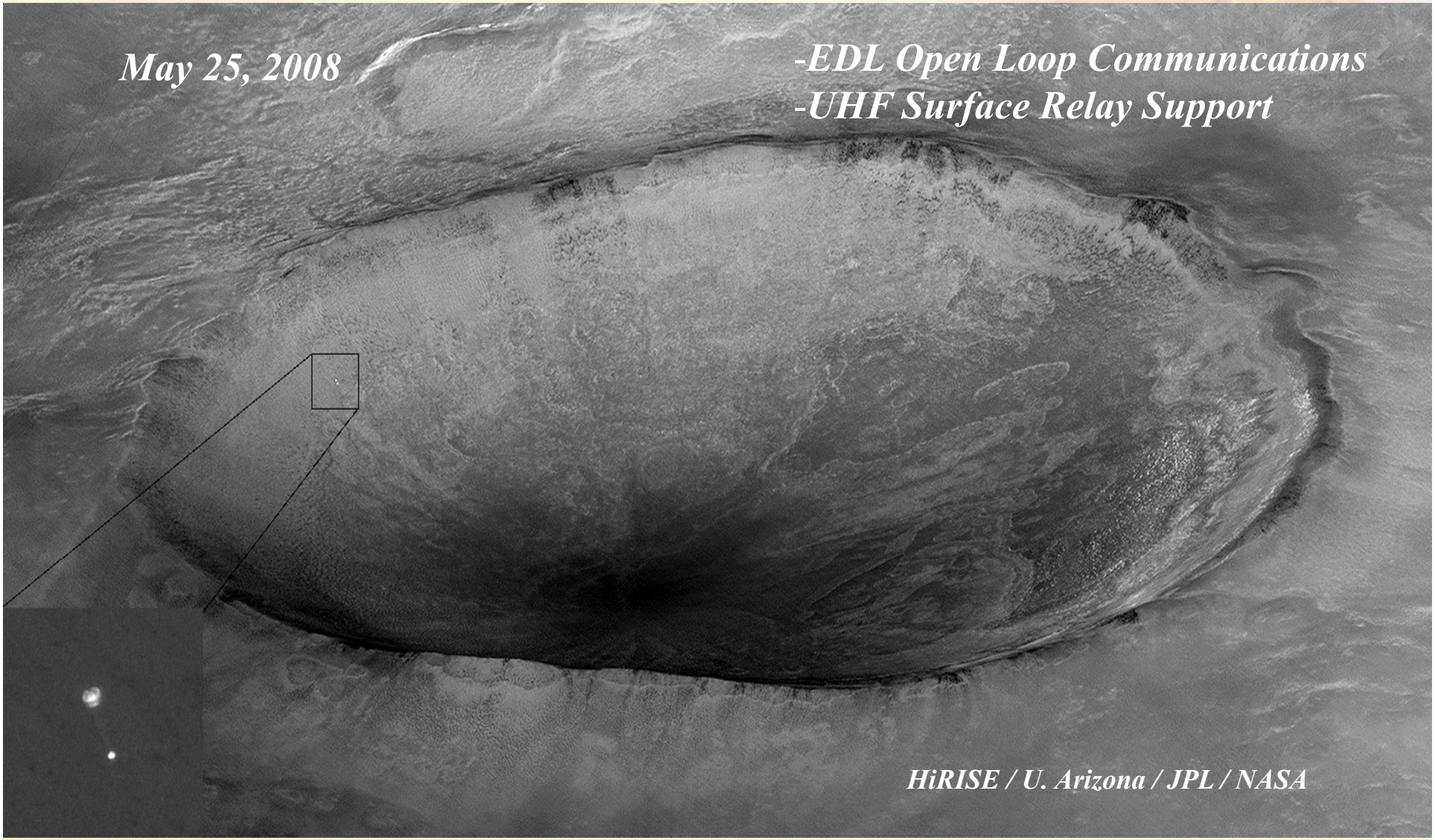
Communications Relay

May 25, 2008

-EDL Open Loop Communications
-UHF Surface Relay Support



HiRISE / U. Arizona / JPL / NASA

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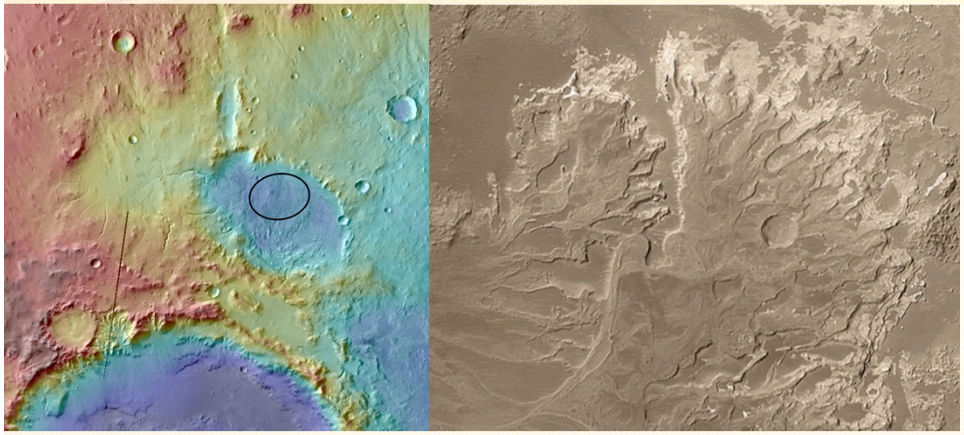
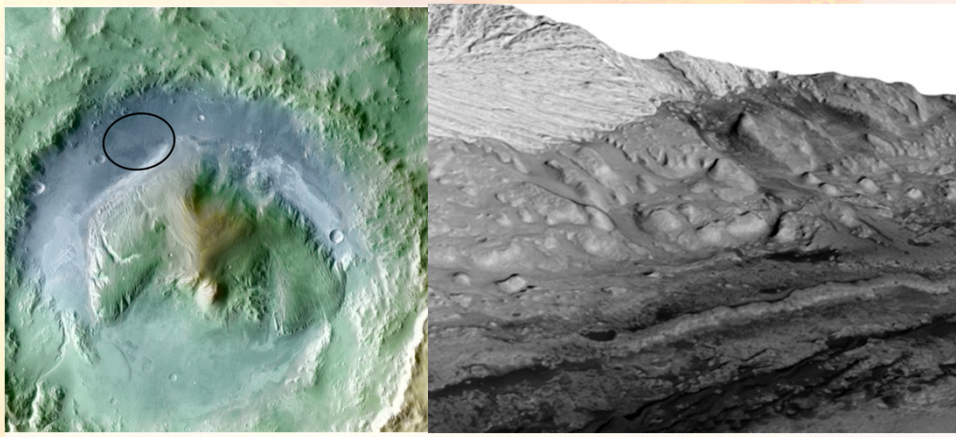
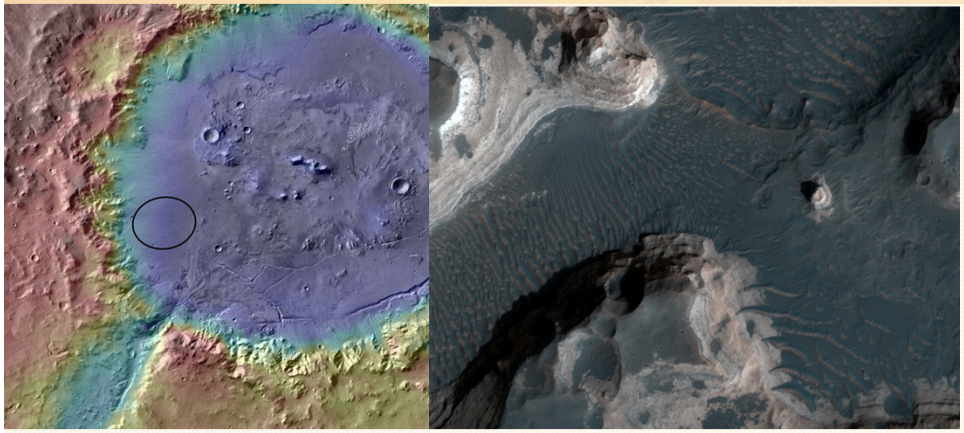
Final Candidate MSL Landing Sites



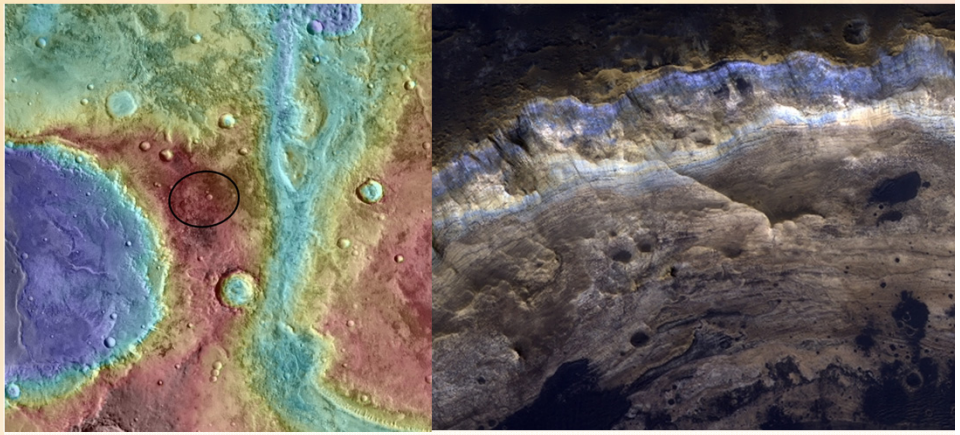
Eberswalde Crater



Gale Crater



Holden Crater



Mawrth Vallis

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Prime Mission Summary

- Over 130 Terabits of Science Data returned
- Acquired over 90,000 images, and image equivalents
  - *65% of the planet imaged at 6 m/pixel (CTX)*
  - *1.2% imaged at 30 cm/pixel (HiRISE)*
  - *75% of planet covered in 72 spectral channels at low opacity*
- Successful UHF Relay Support of the Phoenix Lander

$\Rightarrow$ A diverse planet with a complex geologic history has emerged

- *In particular, the diversity of early water-rich environments shows preservation potential for signatures of ancient life, if it developed*

- MRO has been approved by NASA for a 2-year Extended Mission (FY11 and FY12)

Extended Mission - Objectives & Plans

- Spacecraft is healthy and has large fuel reserves
  - *Paper discusses the flight and mission operations challenges that the Flight Team has encountered*

- Extended Mission Objectives
  - *Science Objectives*
    - *Continuing to acquire and analyze high resolution science data*
  - *Programmatic Objectives*
    - *Support the arrival (EDL) of the Mars Science Laboratory in August 2012*
    - *Provide UHF Relay support to MSL surface operations*
    - *Continue Landing Site scout functions*
  - *FY11 – Complete the development of capabilities that integrate new relay support functions with science data acquisition & return activities*
    - *"Rolled" (vs Nadir) Relay Passes - Enhance link performance*
    - *UHF Radio Software Updates - Provide an adaptive (variable) data rate capability to maximize surface data volume return*

Mars Reconnaissance Orbiter (MRO): Extended Dual-Purpose Mission

- Back-up -

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Mars Exploration Science Goals

2000-2010 "Follow the Water": Found evidence of water activity, past and present

2011-2015 "Explore Habitability": Explore a possibly habitable environment

2015- "Seeking Signs of Life": Search for bio-signatures & climate indicators

WATER

When
Where
Form
Amount

Life

Understand the potential for life elsewhere in the Universe

Climate

Characterize the present and past climate and the processes of climate change

Geology & Geophysics

Understand the geological processes affecting Mars" interior, crust, and surface

Prepare for Human Exploration

Develop knowledge & technology necessary for eventual Human Exploration